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Evaluation of selected meat traits in seven-week-old duck broilers

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Investigated were three crossbred duck broiler groups: heavy Star 63, PP54, and Dworka (CaA15), 20 males (M) and 20 females (F) per group. The birds were kept in pens on rye straw, in a separate closed building with regulated environmental parametres, and fed *ad libitum* standard commercial feed mixtures. Body weight was recorded on day 1 and then on week 3 and 7 of birds' life, and feed consumption measured up to the end of rearing period (week 7). At the end of week 7 five M and five F birds selected from each group were slaughtered and their carcasses dissected. Immediately post-slaughter the breast and leg muscle samples were taken for histological fibre identification. Breast and leg muscles pH was determined 15 min and 24 h post-slaughter. Body weight on week 7 of life was significantly highest in the Star 63 birds of both sexes. The lowest feed consumption up to the end of week 7 of life was found in CaA15 while the most desirable feed conversion ratio in males and females Star 63 broilers. The highest slaughter body weight and highest dressing percentage were both found in Star 63 (both sexes), while the lowest body weight was found in both sexes of Dworka broilers. No significant differences were identified in dressing percentage and in the content of carcass elements between the evaluated crossbreds as well as between the sexes. The breast muscle content of carcass with neck was highest in PP54 males (13.7%) and in Star 63 females (14.5%), while the content of skin with fat occurred lowest in CaA15 group (26.5% in males and 27.8% in females). Heavy Star 63 broilers had the lowest white fibre (αW: 28.1 µm in males and 27.4 µm in females) and red fibre (βR: 15.1 µm in males and 14.2 µm in females) diameter of the surface breast muscle, while the light (CaA15) Dworka broilers showed the highest white fibre diameter (αW: 37.2 µm in males and 36.3 µm in females) and red fibre diameter (βR: 16.2 µm in males and 15.6 µm in females).

KEY WORDS: broiler /carcass / duck / meat / muscle fibres /pH /slaughter quality

The world duck meat production constitutes around 4.3% of the overall poultry meat available. The leader is China supplying as much as 68% (2.36 mln ton) of the entire world duck meat production. France takes the second place (6%), next is Malaysia (3%), then Vietnam and Thailand (each 2.5%) – USDA [2006]. In Poland the duck meat production *per capita* per year amounts to 0.4-0.5 kg and is similar to that recorded in Holland and Great Britain, but lower than in China (1.8 kg), and markedly lower than in France (3.4 kg).

The limiting factors for duck meat consumption in Poland is excessive fatness and relatively high price of the duck carcass as well as lack of tradition for consumption of this type of meat. One of the ways of increasing duck meat consumption is to adjust the carcass composition to consumer's demands and to reduce its price by lowering production costs, particularly those of feed.

Research conducted on ducks from breeding strains, interstrain crossbreds and birds kept in the genetic reserve flocks, showed that muscle and fat content of duck carcass depends on the genotype, age, sex and environment (mostly nutrition) conditions [Abdelsamie and Farrel 1986, Górski 1989, Wilkiewicz-Wawro *et al*. 1999, Mazanowski *et al*. 1998, 2001, Mazanowski and Książkiewicz 2004, Adamski *et al*. 2005]. Week 8 of life is considered the optimum slaughter age of meat producing ducks [Górski 1989, 1992, Mazanowski *et al.* 1998, 2001, Kokoszyński and Korytkowska 2005], but satisfactory results can also be achieved when birds are slaughtered at the age of 7 weeks [Wilkiewicz-Wawro *et al*. 1999, Mazanowski and Bernacki 2004, Adamski *et al*. 2005]. Breast and leg muscle chemical composition, water holding capacity and muscle pH, mainly in selection ducks, were also investigated [Witkiewicz 2000, Mazanowski *et al*. 2003, Mazanowski and Bernacki 2004, Mazanowski and Książkiewicz 2004, Wawro *et al*. 2004, Adamski *et al*. 2005]. Some of the research into the microstructure of breast muscle of ducks from breeding strains [Górski *et al*. 1984, Kłosowska *et al*. 1999, Kłosowska and Bernacki 1999, Witkiewicz *et al*. 2004] indicate greater thin fibre content of muscle of fast growing and heavy ducks.

There are several two-strain duck crossbreds currently used for meat production in Poland. Three of them are most common: an imported crossbred Star 63, PP54, and Dworka (CaA15), the latter being crossbred of Cayuga males with Peking females.

The aim of this study was to compare the three selected commercial crossbred meat ducks on week 7 of life, considering their body weight, feed consumption and conversion, dressing percentage, carcass composition, as well as breast muscle pH and microstructure. Conducted research makes it possible to identify crossbreds most suitable for broiler production in either the intensive or the small-scale system.

Material and methods

Investigation was conducted on the experimental farm Wierzchucinek owned by the University of Technology and Life Sciences in Bydgoszcz. The material consisted of three groups of one-day-old crossbred chicks – Star 63, PP54 and Dworka (CaA15)

– reared up to the end of week 7 of life – 20 males (M) and 20 females (F) per group. All the birds were kept in a closed building, in pens bedded with rye straw. During the first 21 days of life (week 1 to 3) the birds of all groups were fed the starter containing 20.6% protein, 2.7% fat, 3.6% fibre and 2801 kcal (11.7MJ) ME/kg, while from day 22 (week 3 to 7) a mixture containing 17.6 protein, 2.7% fat, 4.5% fibre and 2751 kcal (11.5 MJ) ME/kg. From day 8 until the end of rearing the birds were offered, in separate feeding troughs, a mineral mixture (Avimix) blended 1:4 with gravel.

M and F birds were weighed individually on day 1 and subsequently on week 3 and 7 of life. Their growth rate was calculated with the Brody formulae [1945]:

$$t_w = (m_k - m_p) \times 100\% / 0.5 \times (m_{k+} m_p)$$

where:

mk – final body weight;
mp – initial body weight.

During the entire rearing time, the amount of feed offered was recorded for each pen (sex subgroup). At the duck-weighing dates, refusals were collected and their weight recorded to calculate the mean amount of feed consumed by M and F birds, and to evaluate the feed conversion per 1 kg of body weight gain. Whole carcass dissection was conducted on week 7 following the procedure described by Ziołecki and Doruchowski [1989]. Five M and five F birds were selected with body weight near the mean weight for either sex in each group. Muscle pH was determined within breast and leg muscles 15 min post-slaughter (pH_{15}) and after carcasses cooled (pH_{24}) with a blade electrode connected to a CP-401 pH-meter (ELMETRON). The electrode was placed at a 45° angle half-way through the muscle thickness. Surface breast muscle (*m. pectoralis superficialis*) samples for histological examination were taken directly post-slaughter, immediately frozen in a liquid nitrogen (-196°C) and kept there until the analysis time. Ziegan reaction [1985] was conducted on 10 μm muscle slides, prepared with a cryostat, in order to identify white (αW) and red (βR) muscle fibres. Fibre diameters were determined with a projection microscope (lens 20) by measuring 200 fibres of each type for each bird – measurement of the smallest diameter according to the Brook method [1970].

Gathered data were evaluated according to generally accepted statistical methods (means, standard errors) with the STATISTICA PL programme. Significance of differences was verified with the Sheffe test [STATISTICA 2002].

Results and discussion

Body weight of 3-week-old crossbred male (M) and female (F) birds exceeded 1000 g and no significant differences were identified between means for sexes (Tab. 1). Earlier investigations on Peking broilers showed similar [Mazanowski and Książkiewicz 1997, Mazanowski *et al*. 2001, Adamski *et al*. 2005] or lower body

Table 1. Means and their standard errors (SE) for body weight and growth rate in crossbred duck broilers

Trait		Group					
		Star 63		PP54		CaA15	
		M	F	M	F	M	F
Body weight on day 1 of age (g)	mean	53.8	55.2	54.8	54.0	53.3	49.7
	SE	1.1	1.2	0.7	1.1	1.1	0.9
Body weight on week 3 of age (g)	mean	1294	1200	1271	1192	1096	1008
	SE	8.3	22.5	37.6	27.2	20.1	20.3
Body weight on week 7 of age (g)	mean	3302[a]	2913[a]*	2954[b]	2694[b]	2860[b]	2492[b]*
	SE	98.9	82.8	70.1	50.0	38.4	53.5
Growth rate (%)							
weeks 1-3	mean	184	182	183	183	181	181
weeks 4-7	mean	87	83	80	77	89	85

M – males; F – females.
[ab]Means in rows bearing different superscripts differ significantly at P≤0.05.
*Stars indicate sex means significantly differing at P≤0.05.

weight [Kokoszyński and Korytkowska 2005]. The highest body weight on week 7 of life was reached by M as well as F birds of Star 63 group. M birds of this group weighed 3302 g, which is by 348 g more than PP54 and by 442 g more than Dworka (CaA15) males. Wide differences also occurred in the body weight of females. Star 63 females were by 219 g heavier than PP54 and by 421 g than Dworka F birds. Furthermore, Star 63 and CaA15 birds' body weight of males was found significantly greater than that of females. Lower body weight values (2067-2335 g) of various broiler duck crossbreds at the age of 7 weeks were reported by Mazanowski *et al*. [1994], and higher ones by Retailleau [1999] where males weighed 3569 g and females 3322 g. In the current study the growth intensity measured with the growth rate index (Tab. 1) up to the end of week 3 of life occurred very high and exceed 180% in males. From the end of week 3 to the end of week 7 of life the growth rate has decreased in all crossbreds. CaA15 males and females grew the fastest in that period of time.

Broiler groups differed in mean feed consumption (Tab. 2). The lowest intake was shown by the Dworka (CaA15) males and females while the highest by the birds of both sexes from Star 63 group. However, feed intake per kg of body weight gain during the first three weeks of rearing was the lowest in PP54, and the highest in CaA15 birds. During the whole seven weeks of rearing the lowest intake was shown in male and female birds (2968 g and 3347 g, respectively) of the Star 63 group while the highest in Dworka males (3322 g) and females (3813 g). Less values were earlier reported by Mazanowski *et al*. [2001] who, working on four-strain crossbreds of Peking ducks, found that up to week 7 of life the males have used 2629 g, and females 2770 g feed per kg of body weight gain. Retailleau [1999] also observed lower feed conversion in growing Peking males and females (2485g and 2493 g/kg body gain). However, the

Table 2. Feed consumption per bird and per kg of body weight gain in crossbred duck broilers

Week	Group					
	Star 63		PP54		CaA15	
	M	F	M	F	M	F
	Feed consumption per bird (g)					
1-3	2600	2650	2520	2510	2480	2500
1-7	9800	9750	9600	9570	9500	9500
	Feed consumption per kg of body weight gain (g)					
1-3	2009	2210	1985	2107	2262	2480
1-7	2968	3347	3250	3552	3322	3813

M – males; F – females.
Differences between means were not found significant.

feed intake per kg of body weight gain in 8-week-old Peking crossbred ducks [Górski 1989] of strains P11, P22, P44 and P55 varied, respectively, from 3.77 to 4.57 kg.

Mean body weight of dissected 7-week-old Star 63 M and F broilers was significantly higher (Tab. 3) than of PP54 and CaA15 birds. Within the latter, significant differences between the sexes were also identified in body weight at the age of 7 weeks.

Table 3. Means and their standard errors (SE) for dressing percentage and muscle and skin with fat content of carcass in crossbred duck broilers

Trait		Group					
		Star 63		PP54		CaA15	
		M	F	M	F	M	F
Body weight before slaughter (g)	mean	3113[a]	2881[a]	2775[b]	2514[b]	2689[b]	2287[b]*
	SE	69.8	51.7	27.4	55.2	35.0	24.6
Dressing percentage (%)	mean	69.4	70.3	67.9	69.9	69.2	69.7
	SE	0.4	0.4	0.5	0.5	0.5	0.5
Breast muscles content of carcass (%)	mean	13.5	14.5	13.7	13.1	13.7	13.3
	SE	0.9	1.1	0.7	0.3	0.3	0.3
Leg muscles content of carcass (%)	mean	13.6	13.5	12.9	10.4	14.2	13.2
	SE	0.3	0.6	0.6	0.5	0.7	0.7
Breast + leg muscles content of carcass (%)	mean	27.1	28.0	26.6	23.5	27.9	26.5
	SE	0.9	1.3	1.2	1.1	0.9	0.8
Skin with fat in carcass (%)	mean	29.5	27.8	28.0	28.4	26.5	27.8
	SE	1.3	1.3	0.8	0.7	0.5	0.9

M – males; F – females.
[ab]Means in rows bearing different superscripts differ significantly at P≤0.05.
*Asterisks indicate sex means significantly differing at P≤0.05.

Dressing percentage occurred generally high and ranged from 67.9 (PP54 males) to 70.3% (Star 63 females) – Table 3. Lower dressing percentage (64.9-67.3%) in ducks from paternal strains were reported by Mazanowski and Książkiewicz [2004], and Adamski *et al*. [2005], while in those from maternal strains by Mazanowski and Bernacki [2004] and Clayton and Powell [1979] in Peking ducks – from 61.51 to 62.75%.

Content of carcass components was found significantly affected neither by crossbred groups nor sexes. Male carcasses contained from 13.5 (Star 63) to 13.7% (PP54 and CaA15) of breast muscles and from 12.9 (PP54) to 14.2% (CaA15) of leg muscles. However, in females the respective proportions ranged from 13.1 (PP54) to 14.5% (Star 63) of breast muscles and from 10.4 (PP54) to 13.5% (Star 63) of leg muscles. Pooled breast and leg muscles content of carcass was highest in Star 63 males (27.9%) and females (28.0%), while it was the lowest in PP54 males and females (26.6 and 23.5%, respectively). Greater contents of breast and leg muscles (pooled) in 7-week-old P66, P77 and K11 ducks (pooled: 29.1% in male and 28.7% in female broilers) were reported by Mazanowski and Bernacki [2004], while similar or smaller (25.8-26.3%) by Stadelman and Meinert [1977].

The skin with subcutaneous fat content of carcass with neck varied depending on crossbred group and sex and ranged from 26.5 to 29.5% (Tab. 3). There were greater proportions of skin with subcutaneous fat identified in F than in M birds of PP54 and CaA15 crossbreds, while in Star 63 broilres the relation was opposite. In pedigree strains [Kokoszyński and Korytkowska 2005] the skin with subcutaneous fat content of carcasses in males from paternal (A44 and A55) and maternal (P66 and P77) strains ranged from 24.3 to 26.7%, and from 25.4 to 27.5% in females. Lower fat content (19.6-22.1% of skin with fat) was reported by Mazanowski *et al*. [1994] in carcasses of two-strain crossbreds of Peking ducks at the age of 7 weeks and by Kłosowska *et al*. [1999] in 8-week-old A44 (22.12%) and P77 (19.95%) duck broilers. Witkiewicz *et al*. [2004] reported the content of skin with subcutaneous fat in carcasses of the 7-week-old breeding ducks and from the genetic reserve flocks to range from 29.4 to 30.2%. Even higher skin with subcutaneous fat content of carcass (37.5) in 48-day-old Peking broilers was found by Stadelman and Meinert [1977].

Breast and leg muscle mean pH_{15} ranged from 5.82 to 5.94 and it was the lowest in Star 63 males, while the highest in PP54 females (Tab. 4). In accordance with the division of poultry meat into three categories depending upon its initial pH, it was all acceptable as normal meat of good quality [Gornowicz and Czaja 2002]. Muscle pH_{24} showed the decrease in quality (acidity increase) associated with the irreversible of glycolysis and accumulation of lactic acid. The diameter of red fibres (βR) in breast muscle was nearly twice as low as that of white fibres (αW) – Table 4. The greatest αW fibre diameter was found in breast muscles of PP54 males and females, while the smallest in Star 63 crossbreds. The smallest diameter of βR fibres was found in the muscles of Star 63 males and females, and the greatest in Dworka males, as well as Dworka and PP54 females. The smallest diameters of αW and βR fibres in the breast

Table 4. Means and their standard errors (SE) for muscle pH and muscle fibre diameter in seven-week old crossbred duck broilers

Trait		Group					
		Star 63		PP54		CaA15	
		M	F	M	F	M	F
$pH_{15\ min}$ – breast muscles	mean	5.82	5.88	6.00	6.03	5.90	5.83
	SE	0.10	0.06	0.11	0.09	0.04	0.06
$pH_{15\ min}$ – leg muscles	mean	5.94	6.01	5.98	6.10	6.10	6.02
	SE	0.14	0.08	0.07	0.18	0.06	0.13
pH_{24} – breast muscles	mean	5.54	5.32	5.48	5.40	5.52	5.45
	SE	0.07	0.12	0.06	0.15	0.06	0.11
pH_{24} – leg muscles	mean	5.69	5.46	5.62	5.58	5.68	5.59
	SE	0.09	0.10	0.07	0.16	0.07	0.13
Diameter of αW fibres (μm)	mean	28.10	27.40	38.80	38.50	37.20	36.30
	SE	0.62	1.00	0.07	0.16	0.07	0.13
Diameter of βR fibres (μm)	mean	15.10	14.20	15.60	15.60	16.20	15.60
	SE	0.33	0.79	0.08	0.57	0.25	0.27

M – males; F – females.
Differences between means were not found significant.

muscles of M and F Star 63 birds may indicate higher meat tenderness and its greater cooking quality. Thinner muscle fibres in birds of the highest body weight corroborate the earlier report by Kłosowska *at al*. [1999], in which heavier 8-week-old ducks from A44 strain (3025 g) had thinner white (33.66 μm) and red (18.46 μm) fibres than P77 birds (36.96 and 20.87 μm, respectively) of a smaller (2916 g) body weight.

Summarizing, the results presented here indicate that Peking Star 63 crossbreds are the most suitable for commercial duck broiler production. This is due to their high body weight, low feed consumption per kg of body weight gain, a significant proportion of breast and leg muscles in the carcass and thin fibre contents of their meat. Dworka (CaA15) ducks are characterized by lower body weight, good muscle content and low carcass fatness. They are, therefore, well adapted to rearing in small farms.

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Ocena wybranych cech mięsnych 7-tygodniowych kaczych brojlerów

S t r e s z c z e n i e

Badania przeprowadzono na mieszańcach Star 63, PP54, i Dworka (CaA15), zestawionych w trzy grupy genetyczne po 20 kaczorów i 20 kaczek w grupie. Ptaki utrzymywano przez cały okres odchowu w pomieszczeniu zamkniętym, o regulowanych parametrach środowiska, w kojcach na słomie żytniej i żywiono *ad libitum* jednakowymi standardowymi mieszankami przemysłowymi. Rejestrowano masę ciała w pierwszym dniu i w trzecim i siódmym tygodniu życia oraz ilość pobranej paszy. Po siedmiu tygodniach odchowu ubito i poddano dysekcji pięć kaczorów i pięć kaczek z każdej grupy mieszańców. Bezpośrednio po uboju pobrano próbki dwóch mięśni do badań histologicznych. Oznaczono również ich pH po 15 min i 24 h (pH_{15}, pH_{24}) od uboju. W siódmym tygodniu życia istotnie największa okazała się masa ciała kaczorów i kaczek Star 63. Najmniejsze pobranie paszy do końca siódmego tygodnia życia (tj. do uboju) odnotowano w grupie CaA15, a najlepsze wykorzystanie (FCR) – w grupie Star 63. Największą ubojową masę ciała i najwyższą wydajność rzeźną stwierdzono w grupie Star 63 (obie płci), a najmniejszą masę ciała (także obie płci) – w grupie Dworka. Między ocenianymi grupami mieszańców nie udowodniono istotnych różnic w wydajności rzeźnej i udziale podstawowych elementów w tuszce. Udział mięśni piersiowych w tuszce z szyją był największy w przypadku kaczorów PP54 (13,7%) i kaczek

Star 63 (14,5%), a udział skóry z tłuszczem najmniejszy w tuszkach kaczorów (26,5%) i kaczek ((27,8%) grupy Dworka (CaA15). Ciężkie broilery Star 63 charakteryzowała najmniejsza średnica włókien białych αW (kaczory – 28,1, kaczki – 27,4 μm) i czerwonych βR (kaczory – 15,1, kaczki – 14,2 μm) mięśnia piersiowego powierzchownego. Lekkie broilery Dworka (CaA15) cechowały się najgrubszymi włóknami αW (kaczory – 37,2, kaczki – 36,3 μm) i βR (kaczory – 16,2, kaczki – 15,6 μm).